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AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

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Candidate signature _____

GCSE CHEMISTRY

H

Higher Tier Paper 1

Thursday 16 May 2019 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

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Answer **all** questions in the spaces provided.

0 1 This question is about the periodic table.

In the 19th century, some scientists tried to classify the elements by arranging them in order of their atomic weights.

Figure 1 shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

Figure 1

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Period 1	H						
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K Cu	Ca Zn	* *	Ti *	V As	Cr Se	Mn Br
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

0 1 . 1 The atomic weight of tellurium (Te) is 128 and that of iodine (I) is 127

Why did Mendeleev reverse the order of these two elements?

[1 mark]

He reversed so that elements such as Iodine and tellurium were in groups with similar properties.

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0 1 . 2 Mendeleev left spaces marked with an asterisk *

He left these spaces because he thought missing elements belonged there.

Why did Mendeleev's periodic table become more widely accepted than previous versions?

[3 marks]

Mendeleev's had predicted the properties of Missing elements and these elements discovered had to fill the gaps (spaces). The properties of these elements Matched the Mendeleev's predictions

0 1 . 3 Mendeleev arranged the elements in order of their atomic weight.

What is the modern name for atomic weight?

[1 mark]

Tick (✓) **one** box.

Atomic number – Number of Protons in atom.	
Mass number – Sum of neutrons and Protons.	
Relative atomic mass	✓
Relative formula mass	

0 1 . 4 Complete the sentence.

[1 mark]

In the modern periodic table, the elements are arranged in order of

Increasing in the atomic number.

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Chlorine, iodine and astatine are in Group 7 of the modern periodic table.

0 1 . 5 Astatine (At) is below iodine in Group 7.

Predict:

- the formula of an astatine molecule
- the state of astatine at room temperature.

[2 marks]

Formula of astatine molecule At_2

State at room temperature Solid

0 1 . 6 Sodium is in Group 1 of the modern periodic table.

Describe what you would see when sodium reacts with chlorine.

[2 marks]

The sodium burns in an orange flame, forming a white solid of sodium chloride. The colour of the chlorine gas disappears.

10

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0 2 This question is about acids and alkalis.

0 2 . 1 Which ion do all acids produce in aqueous solution?

[1 mark]

Tick (✓) **one** box.

H^+	✓
H^-	
O^{2-}	
OH^-	

The prescence of alkali.

0 2 . 2 Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.

[2 marks]

calcium hydroxide + hydrochloric acid → calcium chloride + Water

Question 2 continues on the next page

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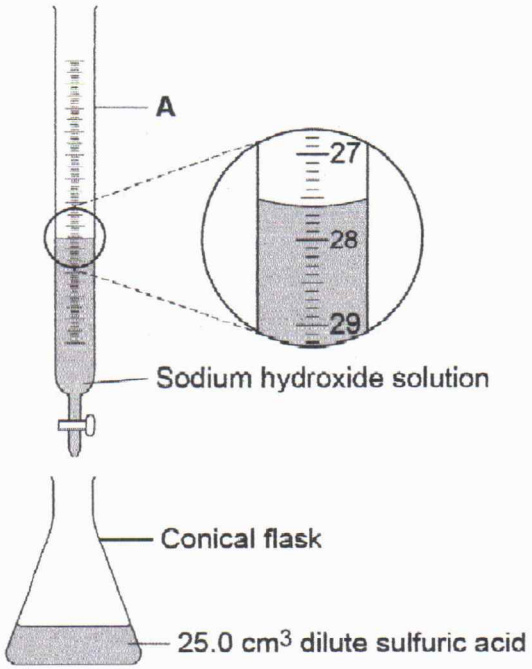
Do not write outside the box

A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm^3 of dilute sulfuric acid.

Figure 2 shows the apparatus the student uses.

Figure 2



Use **Figure 2** to answer Questions **02.3** and **02.4**

0 2 . 3 Name apparatus **A**.

[1 mark]

burette

0 2 . 4 What is the reading on apparatus **A**?

[1 mark]

27.6 cm^3

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0 2 . 5 The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated.

[6 marks]

You are required to Measure the volume of the acid, Add indicator to the acid. Then add sodium hydroxide solution until the colour changes. Record the volume of the sodium hydroxide solution added. Repeat the Procedure again with other acid.

Obtain the results from the titrations and compare the two volumes of the Sodium hydroxide solution and then find the sample which is More concentrated, Whether it is P or Q.

You can add NaOH solution from the burette and Mix until the Indicator changes Colour. Use a White tile so the colour is visible. Record the volume of alkali added. The first attempt should be a rough titration to find the approximate end point. When approximate end Point known, alkali can be added When close to end point. Repeat and take a Mean. Repeat with acid Q and Compare the Volumes of NaOH solution.

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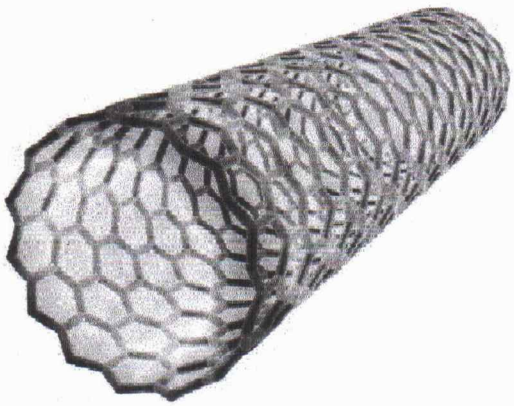
0 3 This question is about materials and their properties.

0 3 . 1 **Figure 3** shows a carbon nanotube.

Figure 3



The structure and bonding in a carbon nanotube are similar to graphene.

Carbon nanotubes are used in electronics because they conduct electricity.

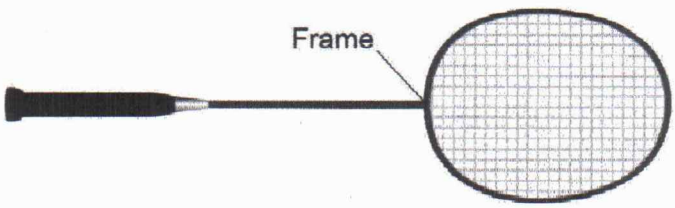
Explain why carbon nanotubes conduct electricity.

[2 marks]

They contain delocalised electrons, so the electrons can move easily through the structure.

0 3 . 2 **Figure 4** shows a badminton racket.

Figure 4



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Do not write outside the box

Table 1 shows some properties of materials.

The materials could be used to make badminton racket frames.

Table 1

Material	Density in g/cm^3	Relative strength	Relative stiffness
Aluminium	2.7	0.3	69
Carbon nanotube	1.5	60	1000
Wood	0.71	0.1	10

Evaluate the use of the materials to make badminton racket frames.

Use **Table 1**.

[4 marks]

The carbon nanotubes have the highest relative strength and able to hit ball further with the racket and withstand force. Carbon nanotubes also have highest relative stiffness out of the three, which means the racket will not bend. Wood has lightest density and makes item light. In Overall I believe carbon nanotubes are best material and has the best strength, stiffness and has a reasonable density.

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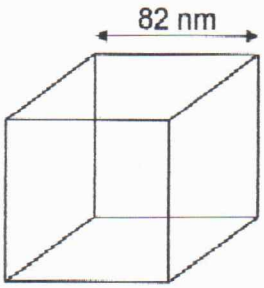
Zinc oxide can be produced as nanoparticles and as fine particles.

0 3 . 3 A nanoparticle of zinc oxide is a cube of side 82 nm

Figure 5 represents a nanoparticle of zinc oxide.

Figure 5



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form.

[3 marks]

Surface area = (82nm x 82nm) x 6 faces of a cube

$= 6724\,nm^2 \times 6$

$= 40,344\,nm^3 \simeq 4.0344 \times 10^4$

Surface area = 4.0344×10^4 nm^2

0 3 . 4 Some suncreams contain zinc oxide as nanoparticles or as fine particles.

Suggest **one** reason why it costs less to use nanoparticles rather than fine particles in suncreams.

[1 mark]

Nanoparticles have longer lasting antibacterial properties than bigger particles of silver.

10

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0 4 This question is about atomic structure.

0 4 . 1 Atoms contain subatomic particles.

Table 2 shows properties of two subatomic particles.

Complete **Table 2**.

[2 marks]

Table 2

Name of particle	Relative mass	Relative charge
neutron	1	0
Protons	1	+1

An element **X** has two isotopes.

The isotopes have different mass numbers.

0 4 . 2 Define mass number.

[1 mark]

Mass number is the sum of neutrons and Protons in an atom.

0 4 . 3 Why is the mass number different in the two isotopes?

[1 mark]

The Isotopes contain different number of neutrons.

Question 4 continues on the next page

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0 4 . 4 The model of the atom changed as new evidence was discovered.

The plum pudding model suggested that the atom was a ball of positive charge with electrons embedded in it.

Evidence from the alpha particle scattering experiment led to a change in the model of the atom from the plum pudding model.

Explain how.

[4 marks]

In the experiment, positively charged alpha particles were fired at thin gold foil. Most alpha particles went straight through the foil. But a few were scattered in different directions. This evidence led Rutherford to suggest a new model of the atom called the nuclear model.
Most of the atom is empty space and alpha particles were deflected, so the atom has positively charged nucleus.

8

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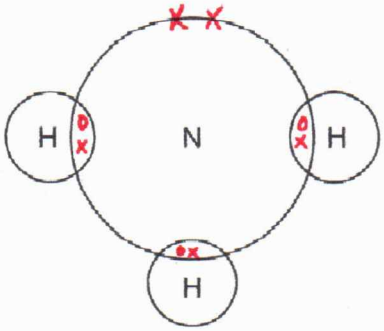
0 5 This question is about ammonia, NH_3

0 5 . 1 Complete the dot and cross diagram for the ammonia molecule shown in **Figure 6**.

Show only the electrons in the outer shell of each atom.

[2 marks]

Figure 6



0 5 . 2 Give **one** limitation of using a dot and cross diagram to represent an ammonia molecule.

[1 mark]

The ammonia molecule is not a three dimensional but has only two dimensional.

0 5 . 3 Explain why ammonia has a low boiling point.

You should refer to structure and bonding in your answer.

[3 marks]

The ammonia has a simple molecular structure and the ammonia molecules are small and held by weak intermolecular forces of attraction thus little energy is needed to overcome the forces (intermolecular forces).

Turn over ▶

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Do not write outside the box

Ammonia reacts with oxygen in the presence of a metal oxide catalyst to produce nitrogen and water.

0 5 . 4 Which metal oxide is most likely to be a catalyst for this reaction?

[1 mark]

Tick (✓) **one** box.

- CaO ☐
- Cr_2O_3 ✓
- MgO ☐
- Na_2O ☐

Figure 7 shows the displayed formula equation for the reaction.

Figure 7

Table 3 shows some bond energies.

Table 3

Bond	N — H	O = O	N ≡ N	O — H
Bond energy in kJ/mol	391	498	945	464

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0 5 . 5 Calculate the overall energy change for the reaction.

Use **Figure 7** and **Table 3**.

[3 marks]

Bond Making

	Bonds formed
$12(N-H) = 391 \times 12 = 4692$ kJ	$2\ N \equiv N = 945 \times 2 = 1890$ +
$3(O=O) = 3 \times 498 = 1494$ kJ	$12\ O-H = 464 \times 12 = 5568$
6186 kJ	7458

Overall energy change = $6186 - 7458$

$= -1272$ kJ

Overall energy change = −1272 kJ

0 5 . 6 Explain why the reaction between ammonia and oxygen is exothermic.

Use values from your calculation in Question **05.5**

[2 marks]

The amount of energy released in making bonds is 7458 kJ, which is greater than energy used in breaking bonds (6186 kJ). This means the products have less energy than reactants, so energy is released to the surroundings.

Question 5 continues on the next page

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Do not write outside the box

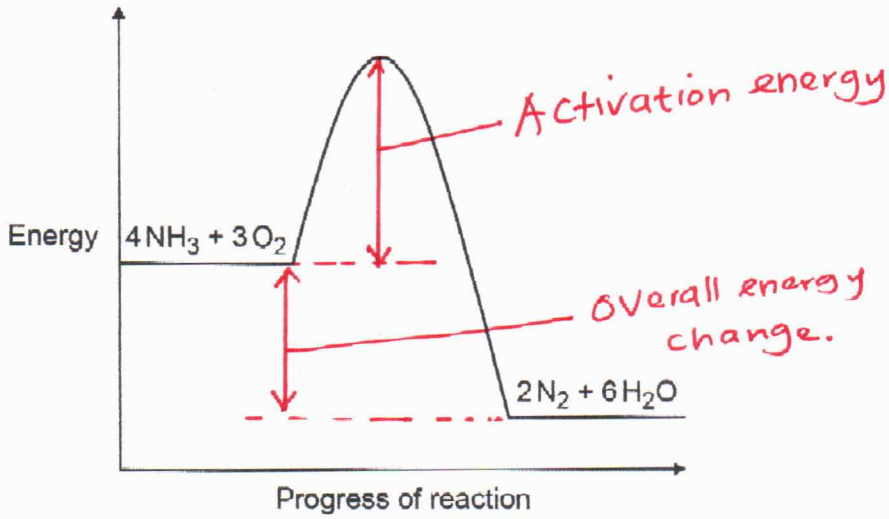
0 5 . 7 **Figure 8** shows the reaction profile for the reaction between ammonia and oxygen.

Complete **Figure 8** by labelling the:

- activation energy
- overall energy change.

[2 marks]

Figure 8



14

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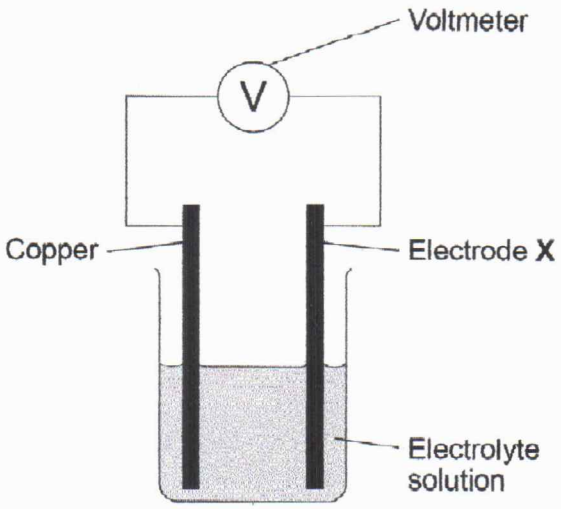
0 6 This question is about chemical cells.

A student investigated the voltage produced by different chemical cells.

Figure 9 shows the apparatus.

Figure 9



This is the method used.

1. Use cobalt as electrode **X**.

2. Record the cell voltage.

3. Repeat steps 1 and 2 using different metals as electrode **X**.

0 6 . 1 Suggest **two** control variables used in this investigation.

[2 marks]

1 The concentration of the electrolyte (solution).

2 The temperature required in the solution

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Table 4 shows the student's results.

Table 4

Electrode X	Voltage of cell in volts
cobalt	+0.62
copper	0.00
magnesium	+2.71
nickel	+0.59
silver	–0.46
tin	+0.48

0 6 . 2 Write the six metals used for electrode **X** in order of reactivity.

Use **Table 4**.

Justify your order of reactivity.

[4 marks]

Most reactive Magnesium

Cobalt

nickel

tin

Copper

Least reactive Silver

Justification The higher the Positive Voltage, the More reactive the metal. Sliver has a negative Voltage therefore it is less reactive than copper.

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0 6 . 3 Which of the following pairs of metals would produce the greatest voltage when used as the electrodes in the cell?

Use **Table 4**.

[1 mark]

Tick (✓) **one** box.

Magnesium and cobalt	☐	3
Magnesium and tin	✓	3.19 ✓
Nickel and cobalt	☐	
Nickel and tin	☐	

0 6 . 4 Hydrogen fuel cells can be used to power different forms of transport.

Some diesel trains are being converted to run on hydrogen fuel cells.

A newspaper article referred to the converted trains as the new 'steam trains'.

Suggest why.

[2 marks]

In the fuel cell hydrogen is Oxidised to produce water. The water produced is released as vapour or steam.

9

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0 7 This question is about electrolysis.

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

0 7 . 1 Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

[2 marks]

The cryolite lowers the melting point of aluminium oxide, therefore less energy is needed.

0 7 . 2 What happens at the negative electrode during the production of aluminium?

[1 mark]

Tick (✓) **one** box.

- Aluminium atoms gain electrons. ☐
- Aluminium atoms lose electrons. ☐
- Aluminium ions gain electrons. ✓
- Aluminium ions lose electrons. ☐

0 7 . 3 Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

[2 marks]

$2O^{2-} \rightarrow O_2 + 4e^-$

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0 7 . 4 Explain why the positive electrode must be continually replaced.

[3 marks]

The graphite electrode reacts with oxygen which forms Carbon dioxide, so the electrode is burned away thus need to be replaced.

0 7 . 5 The overall equation for the electrolysis of aluminium oxide is:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

Relative atomic masses (A_r): O = 16 Al = 27

[4 marks]

R.F.M of Al_2O_3

$(27 \times 2) + (16 \times 3)$

$= 102$

Convert 2000 kg to grams.

$2000 \times 1000 = 2000,000g$

Number of moles of Al_2O_3

$= \frac{2000,000}{102}$

$= 19,607.8$

$\simeq 19608$ moles

2 moles of $Al_2O_3 \rightarrow 19608$

3 moles of $O_2 \rightarrow ?$

$\frac{3 \times 19608}{2} = 29412$ moles

Mass of oxygen $= \frac{29412 \times 32}{1000}$

$= 941$ kg

Mass of oxygen = 941 kg

Turn over ▶

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Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6 Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

During the electrolysis, hydrogen gas would be produced instead of sodium because sodium is more reactive than hydrogen.

0 7 . 7 Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): $Cl_2 = 71$

[2 marks]

Convert 150kg to grams.

$150 \times 1000 = 150,000g$

Number of Moles of $Cl_2 = \frac{150,000}{71}$

$= 2112.6$

$\simeq 2113$ moles

1 Mole of any gas = 24 dm^3

2113 Moles = ?

2113×24

$= 50,712$

$\simeq 50700\ dm^3$

Volume = 50,700 dm^3

16

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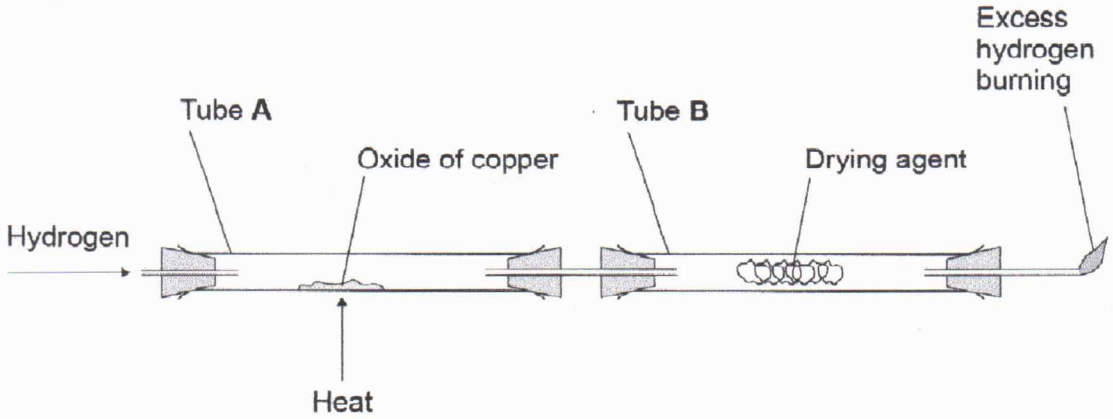
0 8 Copper forms two oxides, Cu_2O and CuO

A teacher investigated an oxide of copper.

Figure 10 shows the apparatus.

Figure 10



This is the method used.

1. Weigh empty tube **A**.
2. Add some of the oxide of copper to tube **A**.
3. Weigh tube **A** and the oxide of copper.
4. Weigh tube **B** and drying agent.
5. Pass hydrogen through the apparatus and light the flame at the end.
6. Heat tube **A** for 2 minutes.
7. Reweigh tube **A** and contents.
8. Repeat steps 5 to 7 until the mass no longer changes.
9. Reweigh tube **B** and contents.
10. Repeat steps 1 to 9 with different masses of the oxide of copper.

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0 8 . 1 Suggest **one** reason why step 8 is needed.

[1 mark]

This is to make sure all of the oxide has reacted.

0 8 . 2 Explain why the excess hydrogen must be burned off.

[2 marks]

This is to prevent hydrogen escaping into the air because hydrogen is explosive.

Question 8 continues on the next page

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Figure 10 is repeated here.

Figure 10

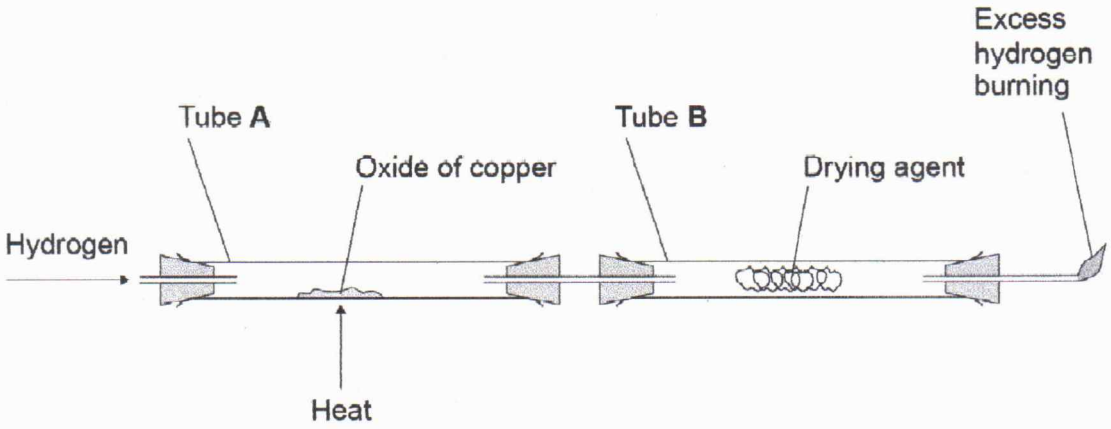

Table 5 shows the teacher's results.

Table 5

	Mass in g
Tube **A** empty	105.72
Tube **A** and oxide of copper before heating	115.47
Tube **A** and contents after 2 minutes	114.62
Tube **A** and contents after 4 minutes	114.38
Tube **A** and contents after 6 minutes	114.38
Tube **B** and contents at start	120.93
Tube **B** and contents at end	123.38

When an oxide of copper is heated in a stream of hydrogen, the word equation for the reaction is:

copper oxide + hydrogen → copper + water

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0 8 . 3 Determine the mass of copper and the mass of water produced in this experiment.

Use **Table 5**.

[2 marks]

Mass of copper = tube A final Mass − tube A empty.
= 114.38 − 105.72
= 8.66 g

Mass of Water = tube B final mass − tube B start
= 123.38 − 120.93 = 2.45

Mass of copper = 8.66 g

Mass of water = 2.45 g

0 8 . 4 The teacher repeated the experiment with a different sample of the oxide of copper.

The teacher found that the oxide of copper produced 2.54 g of copper and 0.72 g of water.

Two possible equations for the reaction are:

Equation 1: $Cu_2O + H_2 \rightarrow 2Cu + H_2O$

Equation 2: $CuO + H_2 \rightarrow Cu + H_2O$

Determine which is the correct equation for the reaction in the teacher's experiment.

Relative atomic masses (A_r): H = 1 O = 16 Cu = 63.5

[3 marks]

Number of Moles of Cu = $\frac{2.54g}{63.5}$ = 0.04 moles

Moles of Water (H_2O) = $\frac{0.72}{18}$ = 0.04 moles

using mole ratio = $\frac{0.04}{0.04} : \frac{0.04}{0.04}$

1 : 1

Correct equation; $CuO + H_2 \rightarrow Cu + H_2O$

8

Turn over for the next question

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0 9 A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25.0 cm^3 potassium hydroxide solution into a polystyrene cup.

2. Record the temperature of the solution.

3. Add 2.0 cm^3 dilute sulfuric acid.

4. Stir the solution.

5. Record the temperature of the solution.

6. Repeat steps 3 to 5 until a total of 20.0 cm^3 dilute sulfuric acid has been added.

0 9 . 1 Suggest why the student used a polystyrene cup rather than a glass beaker for the reaction.

[2 marks]

A Polystyrene is a better thermal Insulator so reduces energy exchange with the surroundings.

Question 9 continues on the next page

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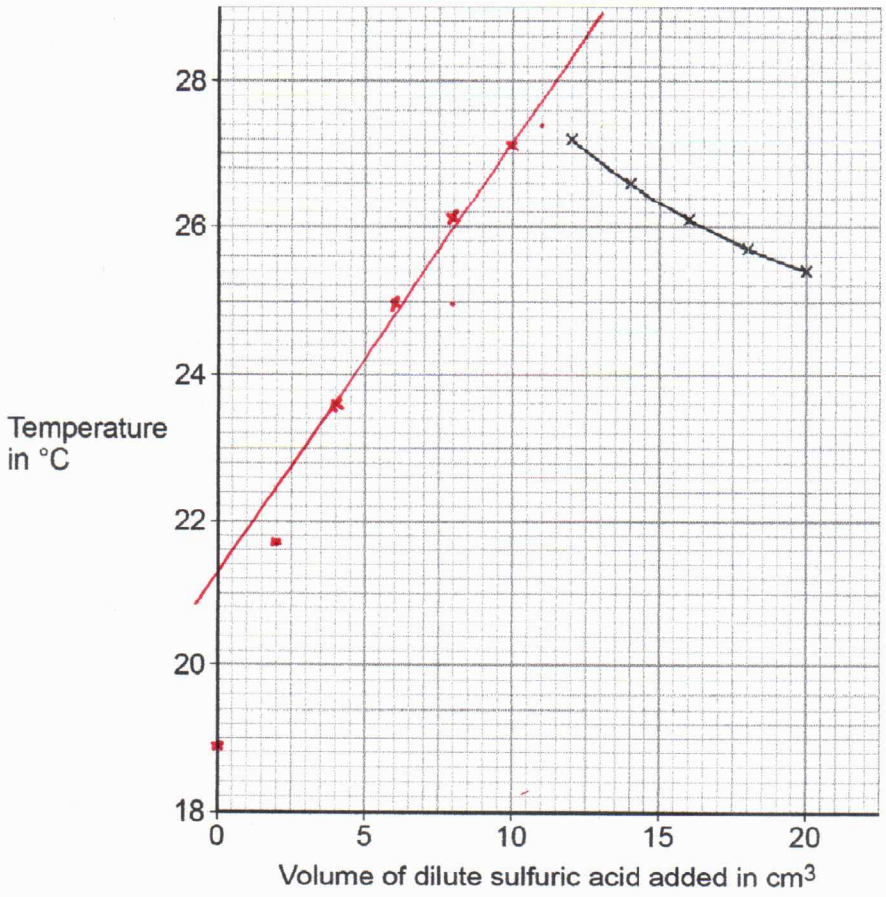
Table 6 shows some of the student's results.

Table 6

Volume of dilute sulfuric acid added in cm^3	Temperature in °C
0.0	18.9
2.0	21.7
4.0	23.6
6.0	25.0
8.0	26.1
10.0	27.1

Figure 11 shows some of the data from the investigation.

Figure 11



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0 9 . 2 Complete **Figure 11**:

- plot the data from **Table 6**
- draw a line of best fit through these points
- extend the lines of best fit until they cross.

[4 marks]

0 9 . 3 Determine the volume of dilute sulfuric acid needed to react completely with 25.0 cm^3 of the potassium hydroxide solution.

Use **Figure 11**.

[1 mark]

Volume of dilute sulfuric acid to react completely = 11 cm^3

0 9 . 4 Determine the overall temperature change when the reaction is complete.

Use **Figure 11**.

[1 mark]

Temperature change = 27·5 − 18·9

= 8·6 °C

Overall temperature change = 8·6 °C

Question 9 continues on the next page

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0 9 . 5 The student repeated the investigation.

The student used solutions that had different concentrations from the first investigation.

The student found that 15.5 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid completely reacted with 25.0 cm^3 of potassium hydroxide solution.

The equation for the reaction is:

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

Calculate the concentration of the potassium hydroxide solution in mol/dm^3 and in g/dm^3

Relative atomic masses (A_r): H = 1 O = 16 K = 39

[6 marks]

Number of Moles H_2SO_4 = $\frac{\text{Volume} \times \text{Concentration}}{1000}$

$= \frac{15.5 \times 0.500 mol dm^{-3}}{1000} = 0.00775$

Number of Moles KOH.

Using Mole ratio $2KOH : H_2SO_4$

2 : 1

$\frac{2 \times 0.00775}{1} = 0.0155$ Moles

Concentration of KOH in Moles = $\frac{0.0155 \times 1000}{25}$

$= 0.62 mol dm^{-3}$

Concentration in grams = (56×0.62)

$= 34.7 g/dm^3$

Concentration in mol/dm^3 = 0.62 mol/dm^3

Concentration in g/dm^3 = 34.7 g/dm^3

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END OF QUESTIONS

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